Diversity and Evolution of Asterids

... asters, ragweeds, and goldenrods ...

Asteraceae - composites
One of the most successful of all flowering plant families with over 1,500 genera and 23,000 species!

- composites found throughout the world but most characteristic of the grassland biomes

Asterales
- 11 families and nearly 26,000 species - Australasia appears to be center of diversity
- no iridoids, latex common, inferior gynoecium, pollen presentation

Bellflower - Campanulaceae
Chickory - Asteraceae

Asteraceae - composites
One of the most successful of all flowering plant families with over 1,500 genera and 23,000 species.

- but also diverse in arctic to tropical and subtropical regions
Asteraceae - composites

Family has 3 specialized features important in this radiation:

1. Special inflorescence "head" - pseudanthia
2. Pollen presentation
3. Diverse secondary chemistry

Pathway to Asteraceae Head?

How did this happen morphologically?

Pozner et al. 2012 (Amer J Bot)
Pollination Syndromes

- wasp
- flies
- moths
- bees
- butterflies
- wind

Pollen Presentation

- Anthers fused forming a tube for pollen release
- Pollen pushed out by a style that acts as a plunger
- Stigma makes contact with self pollen if necessary

Chemical Diversity

- Packera
- Agoseris
- Tanacetum

- polyacetylenes, sequiterpene lactones, terpenes, alkaloids, latex

Chemical Diversity

- Helium hoopesii – Sneezeweed, Owl’s-claw
- Sequiterpene lactones poisonous to sheep in the southern Rockies
- “spewing” disease
Chemical Diversity

*Artemisia annua* – Sweet wormwood

- sequiterpene lactones used in antimalarial treatment
- Chinese herbal medicine

Asteraceae - composites

The head or capitulum is a cluster of 1 or 2 distinct flower types. The family is also called “Compositae” referring to this clustering.

The head is surrounded by special bracts called the involucre or phyllaries.

The involucre is important in the classification and identification within the family.

Asteraceae - floral diversity

- Calyx is reduced to a pappus of scales, awns, bristles, or absent
- Corolla has 5 petals but variously fused or zygomorphic
- Anthers (only) fused in a ring

The fruit is a one-seeded achene with the pappus serving as the fruit disperser (e.g., barbs for animal dispersal, hairs for wind dispersal)
Asteraceae - floral diversity

- the family exhibits a diverse array of floral types
- these three corolla types are seen in Wisconsin

**Main floret types**

1. Disk or tubular florets are actinomorphic
2. Ray florets are usually 3 long fused petals + 2 obsolete petals
3. Ligulate florets are 5 fused petals but split open
Asteraceae - head diversity

These various types of florets combine to form a number of different looking heads

Radiate head: disk florets in the center, ray florets along the edge (these usually pistillate)

Symphyotrichum - aster

Radiate head: disk florets in the center, ray florets along the edge (these usually pistillate)

Liatris - blazing star

Discoid head: only disk or tubular florets comprise the entire head

Asteraceae - phylogeny

- early DNA based work surprisingly placed a small group of South America genera as sister to the rest of the family and recognition of 3 subfamilies and many tribes

Barnadesia lanceolata

- early DNA based work surprisingly placed a small group of South America genera as sister to the rest of the family and recognition of 3 subfamilies and many tribes

Asteraceae - head diversity

These various types of florets combine to form a number of different looking heads

Radiate head: disk florets in the center, ray florets along the edge (these usually pistillate)

Discoid head: only disk or tubular florets comprise the entire head

Ligulate head: only ligulate florets comprise the entire head

Cichorium - chickory
Asteraceae - phylogeny

- early DNA based work surprisingly placed a small group of South America genera as sister to the rest of the family and recognition of 3 subfamilies and many tribes

47.5 million-year-old from Patagonia

Extant member of an early branching lineage of Asteraceae (Mutisioideae), *Cnicothamnus lorentzii*

Asteraceae - phylogeny

- later DNA based work questioned the monophyly of subfamily Cichorioideae - classification still in progress

Asteraceae - tribes

Tribe Barnadesiinae

Small South American tribe with bilabiate (C) or pseudolabiate (D) corolla - similar to some other families of Asterales

*Barnadesia lanceolata*
Asteraceae - tribes

**Tribe Mutisieae**

South American tribe usually with bilabiate flowers; characteristic of tepuis in northern South America.

**Stomochaeta**

**Duidaea**

**Cerro Autana**

Asteraceae - tribes

**Tribe Lactuceae (Cichorieae)**

Only have ligulate heads, milky latex in vegetative parts, pappus of filaments.

Dandelion, goat’s-beard, chicory, hawkweed

**Taraxacum** - dandelion

Asteraceae - tribes

**Tribe Lactuceae (Cichorieae)**

**Cichorium intybus** - chicory

Eurasian weed - totally naturalized and distributed widely even to Botany 400 plant collections.

Asteraceae - tribes

**Tribe Lactuceae (Cichorieae)**

**Krigia biflora** - false dandelion

**Hieracium** - hawkweeds
**Asteraceae - tribes**

**Tribe Cardueae (Cynareae)**

- *Cirsium* - thistles
  - spiny phyllaries and often leaves and stems
  - heads never radiate
  - petals white or cyanic colors (blues, purples)
  - thistle, knapweed, burdock

**Centaurea maculosa** - Spotted knapweed

**Arctium** - burdock

**Tribe Vernoeae**

- Alternate leaves
- Purple flowers generally

**Hesperomannii**

- Hawaii

**Vernonia fasciculata** - ironweed

**Tribe Inuleae (Gnaphalieae)**

- Plants usually covered with white hairs, pappus of bristles or hairs

- Pussy toes, cudweed, pearly everlasting

**Antennaria plantaginifolia** - pussy toes
Asteraceae - tribes

**Tribe Inuleae (Gnaphalieae)**

*Anaphalis margaritacea* - pearly everlasting

**Tribe Astereae**

*Symphyotrichum pilosus* – frost aster

*Symphyotrichum novae-angliae* - New England aster

**Tribe Astereae**

Conspicuous rays in radiate head, pappus of plumose bristles; asters, goldenrods, fleabanes

*Symphyotrichum pilosus* – frost aster

(Botany 400 plant collections)

**Tribe Anthemideae**

*Leucanthemum vulgare* – ox-eye daisy

Ox-eye daisy, yarrow, wormwood, tansy, dog fennel

*Tanacetum bipinnatrum* – Lake Huron tansy

Aromatic plants, with dissected, alternate leaves; pappus of awns or scales or missing

*Ox-eye daisy, yarrow, wormwood, tansy, dog fennel*
Asteraceae - tribes

Tribe Anthemideae

*Achillea millefolium* – yarrow (Botany 400 plant collections)

*Matricaria discoidea* – pineapple weed

Tribe Senecioneae

*Packera aureus* – golden ragwort

Alternate or basal leaved, phyllaries in 1 row, capillary pappus; ragwort, Indian plantain

Asteraceae - tribes

Tribe Helenieae

*Helenium autumnale* – common sneezeweed

*Gaillardia aristata* – common blanket-flower

Alternate leaved, radiate heads, 3-lobed ray flowers always widest at tip

Tribe Heliantheae

*Ratibida pinnata* – coneflower

*Helianthus annuus* – sunflower

Large tribe with radiate, multi-layered phyllaries, rays mostly yellow, tendency for opposite leaves

Coneflower, sunflower, rosinweed, ox-eye, black-eyed Susan, prairie dock, coreopsis, Peruvian daisy
Asteraceae - tribes

**Tribe Heliantheae**

*Biden cernua* - bur marigold

*Echinacea pallida* - purple coneflower

**Tribe Ambrosieae**

*Ambrosia artemisiifolia* - ragweed

Male florets

Female florets

Unisexual and wind pollinated, rays absent, stamens not fused

Ragweed, cocklebur

**Tribe Eupatorieae**

*Eutrochium maculatum* - Joe-pye weed

*Eupatorium perfoliatum* - Boneset

Opposite or whorled leaves

Discoid heads

Corolla never yellow

Joe-pye weed, boneset, snakeroot, blazing star